Suggestions for the Composition of Technical Reports in the Natural-Resource Sciences

By

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Abstract. Suggestions are provided for language, usage, organization of material, and paragraph construction and for the avoidance of special difficulties in composition. Appendixes list style guides and manuals on English grammar and provide explanations for preferred usage and for corrections of common flaws in technical reports.

Key words: Manuscripts, periodicals, publishing, writing.

In addition to language, usage, and organization of material, I address special difficulties in composition and provide lists of standard references in natural-resource sciences. The suggestions are not comprehensive but address widespread and common mistakes and flaws that came to my attention during editing manuscripts on topics in the natural-resource sciences and while providing assistance to authors with shaping and polishing compositions.

Language

Standard formal English (Warriner and Griffith 1977) is most suitable for technical reports because it minimizes inadvertent ambiguities and eases communication between the author and a multidisciplinary, international circle of readers. Standard formal English is neither terse nor rigid and does not impair or preclude reader-friendly prose.

Colloquial and figurative expressions and slang must be avoided in technical and scientific reports because they may be misinterpreted. Jargon should be used only if it cannot be avoided but if used must be defined at first usage.

Sentences may be written in the active or passive voice. In the active voice, the subject of the sentence does the action (e.g., I observed the animals; we concluded that); in the passive voice, the subject receives the action (e.g., the animals were observed; the conclusions were made). The active voice gives compositions vigor, directness, and clarity and subtly conveys the investigator's ownership of innovative ideas, clever procedures, and novel conclusions. Although the passive voice has its place, its excessive use may erroneously relate detachment of the author from the composition.

Usage

Appropriate Choice of Words

Judicious usage is imperative to unambiguous writing. Sole or principal reliance on dictionaries is not advisable. Dictionaries are not ultimate guides for usage but are reference books with information about spellings, forms, pronunciations, functions, etymologies, meanings, and syntactical and idiomatic uses (Merriam-Webster, Inc. 1993)—not necessarily preferred uses—of words. A writer's reference library should include one or several style guides (Appendix A) with annotations about appropriate and preferred usage.

For example, *while* may mean *and*, *but*, *although*, or *whereas* in addition to *at the same time* and *during the time that*. Copperud (1980), however, pointed out that *while* is best reserved to mean *at the same time* or *during the time that* because it may be ambiguous if used in the sense of *and, but, although,* or *whereas*.

Faulty usage (Appendix B) is common in the popular literature but can easily be avoided in technical report writing. Again, the avoidance of ambiguous meanings is imperative to the composition of technical reports.

Avoiding inappropriate usage may require periodic study of grammar and style guides (Sabin 1993; Hacker 1991; Merriam-Webster 1991; Warriner and Griffith 1977). Some authors may consult author's editors (Cox 1991), particularly for complex or lengthy manuscripts.

Author's editors help scientists with all aspects of composition to make the information flow logically and clearly. They may even conduct literature searches, construct tables, finalize illustrations with computer graphics software, and perform other helpful tasks. In addition to excellent writing skills, author's editors may have strong scientific backgrounds.

Jargon

If jargon—specialized language that is used by members of a trade, profession, or group—cannot be avoided, it must be defined at first usage and must then be used consistently in the same form. However, authors should not feel obligated to use misnomers (e.g., successful nests, nest success) even if they have repeatedly appeared in print and are widely accepted. Replacement of the misnomer with an appropriate term (e.g., successful nesters, successful nesting) and, if necessary, its definition is the mark of a skillful writer.

The common names of organisms must be spelled out and not be replaced with jargon. For example, emperor geese (*Chen canagica*) should not be called *emperors*, and redear sunfishes (*Lepomis microlophus*) should not be called *shellcrackers*.

Non-sexist Usage

The English language has reflected the cultural attitudes toward women and women's positions in society. Special style guides (Miller and Swift 1988; International Association of Business Communicators 1982; Appendix A) provide unbiased alternative expressions for chairman, postman, milkman, man-made, salesman, sportsmanship, mankind, and so on and assist with the recasting of sentences. For example, *handmade, synthetic, manufactured, fabricated, machine-made,* or *constructed* are many unbiased, even specific alternatives to *man-made*. “The award is for sportsmanship” is more skillfully expressed as “The award is for the highest ideals of fair play” (Miller and Swift 1988:40).

Wordiness

The use of many—usually too many—words is widespread and creates cumbersome and laborious reading. Examples of “excess baggage” (Eschmeyer 1990:9) could fill a book. Because many grammar books and writing guides provide ample examples and corrections of wordiness, I list only a few examples of common wordy expressions in manuscripts that I reviewed.

fish and wildlife resources	fishes and wildlife
control effort	control
in cases where	when or if
in the fall season	in fall
in the year of 1995	in 1995
research effort	research
rainfall event	rainfall
drought period	drought
we make the following recommendations	we recommend

The CBE Style Manual (CBE Style Manual Committee 1983) lists annotated references to style guides and grammar books.

The birds were observed to build nests can be recast *The birds built nests*. Had they not observed the activities of the birds, the investigators obviously could not report them. Only when authors must distinguish between observations and indices of activities is the expression *observed to* necessary.

A colleague (C. Madsen, U.S. Fish and Wildlife Service, Region 3) told me that in his experience the public is annoyed and suspicious of the word *program* because the federal remedy of every problem is another program. Indeed, the word often seems to be superfluous. *Federal control* or *federal management* in place of *federal control program* or *federal management program* probably suffice, unless *program* is part of the proper name.

Erroneous Attributes

In spite of their obvious faults, expressions such as *This paper discusses*, *The objectives of this paper are . . .*, or *The study proves* . . . are common, even in published works. *I discuss* . . . , *My objectives were* . . . , or *We demonstrated* . . . are appropriate expressions that convey confidence by the investigators.

The Proper Tense

The present perfect tense (e.g., I have been, we have had, they have lived) seems to be the most misused tense. It should be used to express actions that started in the past and continue into the present (e.g., I have lived in Colorado for 20 years) and actions that occurred in an undefined past (e.g.,Oh yes, I have been to the Middle East). The past tense—not the present perfect tense—must be used for something that was completed in the past. For example, *We moved to Philadelphia in 1978* or *I conducted a study during 1989<F128W1>-<F255MI>91*.

The results of an investigation are usually described in the past tense. For example, "Downstream migration in spring usually peaked in April in the Ocqueoc and Big Garlic rivers" (Hanson and Swink 1989:330). However, facts are usually stated in the present tense; for example, "The humpback whale is basically oceanic but enters shallow, tropical waters for the winter breeding season" (Nowak 1991:1034).

The, A, and An

Some or maybe many writers omit the articles *the* and *a* or *an* for the sake of brevity or to save page charges on shorter articles (personal observation). The consistent omission of the articles can create an unfriendly, terse, and even brusque style that impedes comprehension of both complex and uncomplicated material. As a general rule (Copperud 1980:377; Hacker 1991),"*The* particularizes what it precedes; *a* and *an* designate one of a class." For example, in *the biomass of the plants in Plot A was greater than the biomass of the plants in Plot B*, the articles convey that the biomasses and the plants are known entities. Conversely, the articles are omitted in statements of general facts such as *Ducklings are precocious* or *Wetlands are important habitats of surface-feeding ducks* because each noun is one type of a larger class. The articles in *I observed the bear from a truck* identify a particular bear and a vehicle of a class of vehicles–trucks. In other words, the investigator observed a particular bear from a nonspecific truck.

Organization of Material

The traditional organization of material into four principal parts—introduction, methods and materials, results, and discussion—is suitable for many reports about experiments, investigations, inventories, and studies of natural resources. The main body of the report is usually preceded by an abstract or concluded with a summary. However, a summary is usually not required if the paper is preceded by an abstract. Lengthy papers may benefit from a section with a brief summary of the major conclusions. Biologists are familiar with the four-part organization and like it because they can quickly extract specific information about any aspect of a study.

In the treatment of some topics, however, different and frequently unique organizations of material are required. For example, evaluations of methods, investigations, or models also begin with introductions, but the subsequent organization of the material may be by the various aspects or details of the topic or by treatments of previous investigators or critics.

Irrespective of type of organization, the material must be rigorously organized by the structure of the selected organization (CBE Style Manual Committee 1983). Some authors consult checklists, and the guide for contributors to the technical report series of the National Biological Survey includes a checklist (Appendix C). A basic checklist may be as follows:

Abstract

- usually should not exceed the shorter of 250 words or 3% of the length of the manuscript
- briefly but concisely identifies the author's objectives and methods, lists the principal results, and states the major conclusion
- includes scientific names of major organisms

Introduction

- briefly but concisely outlines the topic of the paper
- states the reason for the study
- concludes with listing the objective(s)

Methods and Materials

- states the period of the study
- gives the location and a description of the study site (a necessary comprehensive description of the study site may be presented under a separate heading that precedes Methods and Materials)
- provides a systematic description of methods and materials in a logical order
- references standard procedures; if described, descriptions of standard procedures are summaries
- avoids listing results and does not include discussions
- lists the type and reason for statistical tests that were used and the *P*-value for level of accepted significance

Results

- presents a systematic description of results in the same order as the description of methods
- does not include descriptions or iterations of methods, discussions, or conclusions
- does not present results in statistical jargon; presents differences with the comparative form of adjectives (A is larger than B, D ran faster than C, and so on); lists symbols and values of test statistics and other applicable values (e.g., *n* or *df*) in parentheses after the comparative forms of adjectives
- acknowledges only differences at $P \leq 0.05$ or at an otherwise stated level of significance
- summarizes contents of each table in one to three statements, followed with the table number in parentheses (readers are not merely referred to tables to fend for themselves)

Discussion

- focuses on the purpose of the study
- addresses the objectives
- presents the principles, relations, and generalizations that the results revealed
- does not merely repeat results without a conclusion or argument (the author discusses results without recapitulating them)
- points out exceptions or lack of relations and defines unsettled points
- shows how results and interpretations agree or contrast with those in previously published works
- presents a tightly reasoned argument in crisp, clear sentences and in a logical sequence of paragraphs

Order and Construction of Paragraphs

The paragraphs under each heading or subheading must be in a recognizable order. Common types of order (Hacker 1991) are by chronology or by another scale of time, by space, or by complexity. Whereas the methods and results of studies are best described in chronological order, the components of a discussion may best be given in order of complexity. Logic also frequently dictates the order of paragraphs—notably in introductions (which explain the reasons for a study) and in discussions (which set forth arguments).

Paragraphs are not constructed by hard and fast rules. However, topic sentences are useful because they state the content of a paragraph and explain the reason for the paragraph—such as a shift in ideas or the beginning of a new phase in descriptions. However, writers must beware of wordiness. For example, a paragraph is wordy if it starts with a sentence such as *Specimens are kept in several types of containers* and continues with another sentence that describes the various containers. A better topic sentence is *Specimens are kept in glass bottles, paper cartons, or plastic containers* and may be followed, for example, by descriptions of the disadvantage or usefulness of each type of container.

Similarly, a paragraph that starts with, for example, *Many researchers investigated the biology of the white-tailed deer (*Odocoileus virginianus*)* is wordy and, moreover, begs for references even if a subsequent enumeration of specific studies is referenced. Such sentences may be safely omitted. The enumeration of referenced research conveys the comprehensive study of the species. The paragraph may be started with *Comprehensive studies of the biology of the white-tailed deer (*Odocoileus virginianus*) were done by . . .*.

Further discussion of paragraph construction is beyond the scope of this leaflet. The subject is treated comprehensively in style guides and in writing guides.

Construction of Tables

A properly constructed and oriented table is reader friendly, adds eye appeal to a composition, and eases the comprehension and the comparisons of data. Each table must, however, stand independently from the rest of the paper (CBE Style Manual Committee 1983). For this reason, the table title must include the location and dates of the study, scientific names of organisms, and other pertinent information. Furthermore, the body of a table must be without vertical or horizontal rules. Values must be vertically oriented because comparisons of data are easier down columns than across rows. The units of measure are usually stated in the box heading to avoid clutter in the columns.

Unless a publication outlet provides guidelines, the comprehensive instructions, which include illustrations of tables, in the *CBE Style Manual* (CBE Style Manual Committee 1983) should be followed.

Figures

Like tables, figures must stand independently from the rest of the paper (CBE Style Manual Committee 1983),

and each figure caption must include the location and dates of the study, scientific names of organisms, and other pertinent information. Unless an outlet provides guidelines, the *CBE Style Manual* (CBE Style Manual Committee 1983) may be consulted for the preparation of figures. Whether figures are line drawings or photographs, they must be originals and of professional quality. Photographs should be sharp, glossy, unmounted prints. Line drawings should be in black ink on drafting paper or on illustration board. Freehand or typewritten lettering is not acceptable. Press-on lettering may be used, but laser printer lettering is preferred. The lettering style in a series of line drawings must be uniform. Hard copies of computer-generated figures must be accompanied by a diskette and identification of the software.

Special Difficulties of Technical Compositions

Descriptions of Methods

The methods section is comparable to a recipe. All materials and methods must be described in the methods section so that someone else can repeat the investigation or the experiment in detail. Describing methods and materials in chronological order of the procedures during the investigation or experiment is appropriate. However, some writers' perceptions of a need for a description of methods in a strict chronological order are erroneous. For example, investigators collect data before they realize during subsequent analyses that some or all data do not meet the assumptions for an examination with (for example) parametric statistical tests. The appropriate tests are therefore selected after the collection of data, and some authors erroneously assume that the descriptions of the transformation of data or the use of nonparametric tests must be stated in the results section.

The transformation of data or use of nonparametric tests for the examination of some or all data must be stated in the methods section. For example, *Nonparametric tests (Mann-Whitney U-test) were used when the assumptions for parametric tests could not be met*, *Logarithmic transformation was used for data on phytoplankton*, and similar statements are appropriate in the methods section.

Descriptions of Results

Descriptions of test results with the comparative form of adjectives and adverbs pose difficulties for many writers. Awkward sentences with erroneous usage such as *Weight of chicks in treatment A was high compared to controls*, and *The biomass of experimental species was low relative to reference species* are common.

Comparisons are best stated with the comparative form of adjectives and adverbs. The sentence starts with the common characteristic. For example, "The weights of chicks were greater in Treatment A than in Treatment B." The sentence should conclude with the symbol and value of the test statistic and related values in parentheses. For example, "Fewer earthworms [of] 50 mg ww were in the acid-treated plots than in the control plots ($X^2 = 13.68$, $df = 2$, $P < 0.01$)" (Esher et al. 1993:78) or "The catch of recently metamorphosed sea lampreys showed a gradual but highly significant decline after chemical treatment of the river in October 1968 (U-test, $N_1 = 4$, $N_2 = 7$, $P < 0.01$)" (Hanson and Swink 1989:328).

Laborious descriptions of results from comparisons by treatment or by location can be and should be avoided. A general statement about the results can precede a reference to one or several tables in which results are grouped in a logical fashion. For example, "In June 1987, trout–perch dominated samples at most locations (Table 1)" (Wolfert and Bur 1992:3) or "Sites varied in temperature from 6.3 to 12.3°C (Table 1)" (Snyder-Conn 1993:3).

Descriptions of Statistical Treatment of Data

Unless a manuscript is a treatise of statistical methods or models, the descriptions of statistical treatment of data and of test results must not prevail over the descriptions of the meaning of test results in the context of the investigation. Applications of standard tests such as an analysis of variance, *t*-tests, Kruskal-Wallis, and others are simply stated in the methods section, possibly in a separate paragraph. For example (Carl et al. 1994:131):

> One-way analysis of variance was used to test for differences in meristic data between fish samples from 1983 and 1987 (Snedecor and Cochran 1980). Genetic homogeneity within samples was assessed, based on estimated deviations from Hardy-Weinberg proportions, with the chi-square goodness-of-fit test (Hartl 1987). The log-likelihood G-test (Sokal and Rohlf 1981) was used to assess differences in allelic frequencies between the Wampus Creek and coastal and inland populations reported in the literature.

Some editors do not request references for standard tests such as the Student's *t*-test or the analysis of variance. Variations of standard tests must be described briefly unless the variations were published and can be referenced.

Detailed descriptions of the investigator's unsuccessful attempts to analyze data by various methods are rarely necessary. Statements about the conducted tests and results should be limited to parenthetical references. Results should be described with comparative adjectives and adverbs; again, the symbols and values of the test statistics and related values should be stated in parentheses. For example, "Radio-marked females produced smaller clutches ($F = 8, 55; 9, 274$ *df*; $P = 0.0001$) and smaller eggs ($F = 2, 59; 8, 185$ *df*; $P = 0.010$) than unmarked females" (Pietz et al. 1993:700).

Many editors recommend that authors state the exact *P*-values rather than $P \leq 0.05$ or $P > 0.05$. Statistical significance is usually assumed at $P \leq 0.05$. The author's acceptance of statistical significance at other than $P \leq 0.05$, for example $P \leq 0.1$, must be stated in the methods section. Statements with comparative forms of adjectives or adverbs that are followed by a qualification that the difference was not statistically significant are erroneous and inappropriate (e.g., The yellow apples were larger than the red apples, but the difference was not statistically significant). If results approached statistical significance, I recommend its mention in the discussion section.

Because the analysis of data is by a stipulated level of significance, the description of results in terms of *significantly different*, *significantly greater*, *significantly slower*, and so on is wordy. The comparative forms of the adjectives or adverbs do not require *significantly*. For example, the sentence "Catches were significantly greater (Wilcoxon signed-rank test, $N = 11$, $P < 0.05$) in fall than in spring" (Hanson and Swink 1989:329) should be recast *Catches were greater (Wilcoxon signed-rank test, $N = 11$, $P < 0.05$) in fall than in spring*.

Annotated Bibliographies

Annotated bibliographies traditionally provided indicative annotations—brief descriptions of the general contents of publications. Bibliographies alleviated researchers and managers from costly searches for available information, and the annotations simplified the selection of specific publications for in-depth examination.

Electronic searches of databases are now simple, available, and affordable to nearly everyone. Consequently, users of annotated bibliographies are more demanding. In place of annotations that are brief comments or explanations about a document or its contents (CBE Manual Style Committee 1983), users expect abstracts with descriptions of principal methods and preferably quantitative findings.

To provide appropriate annotations, authors of bibliographies must modify an author's abstract or compose an annotation in their own words. These annotated bibliographies provide users with a compact package of condensed specific information about a topic.

Good examples of contemporary annotated bibliographies were authored by Dahlgren and Korschgen (1992) and York (1994).

Placement of References

References—sources of information—must accompany assertions and information in the text, and the placement of references must be unambiguous. Providing one or several references at the end of a paragraph is not specific and imposes on the reader who must obtain all the references and match them with information or assertions.

The accommodation of references in proper places is probably the most difficult obstacle to a smooth flow of phrases. References must be in locations that clearly identify the relation between the information and the source. Diction and punctuation can be used for the appropriate placements of references. For example, *Doe (1755) demonstrated that eggs of this fish hatch only in murky water, and Smith (1760) was unsuccessful in his attempts to keep the fry alive in clear water*. Or, *Eggs of this fish hatch only in murky water (Doe 1755) and fry did not survive in clear water (Smith 1760)*. If several findings may be attributed to the same source, phrases are separated by semicolons.

For example: *The fish spawns in wetlands; eggs hatch only in murky water (Doe 1755)*. If an entire paragraph of facts about a fish is attributable to one source, diction is useful. For example: *A recent study (Doe 1755) revealed that this fish spawns in wetlands and the eggs hatch only in murky water. The same study revealed that the fry do not survive in clear water* . . . and so on.

Punctuation, diction, or the structure of sentences and paragraphs can be used for the appropriate placement of references. With practice, authors usually create personal, acceptable styles and use them without difficulty.

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York, D. 1994. Recreational-boating disturbances of natural communities and wildlife: An annotated bibliography. National Biological Survey Biological Report 22. 29 pp.

Appendix A. Style guides for English usage and manuals for English grammar.

Style Guides

General Style Guides

CBE Style Manual. 1983. Fifth edition, revised and expanded. Council of Biology Editors, Inc., Bethesda, Md. 324 pp. (**Sixth ed.**, 1994, [reprinted 1995, 1996, 1997] is the latest as of 1999 and more than twice as big as the fifth edition. New title: ***Scientific Style and Format.*** CBE. Cambridge University Press, 826 pp.)

Copperud, R. H. 1979. American usage and style: the consensus. Van Nostrand Reinhold Company, New York, N.Y. 433 pp.

Follett, W. 1966. Modern American usage: a guide. The Noonday Press, New York, N.Y. 436 pp.

Fowler, H. W. 1965. A dictionary of modern English usage. Second edition. Oxford University Press, New York, N.Y. 725 pp.

O'Hayre, J. undated. Gobbleddygook has gotta go. U.S. Government Printing Office, Washington, D.C. 113 pp.

Strunk, W., Jr., and E. B. White. 1979. The elements of style. Third edition. MacMillan Publishing Co., Inc., New York, N.Y. 92 pp.

The Chicago Manual of Style. 1982. Thirteenth edition, revised and expanded. The University of Chicago Press, Chicago and London. 738 pp.

Words into Type. 1974. Third edition, completely revised. Prentice-Hall, Inc. Englewood Cliffs, N. J. 583 pp.

Style Guide for Papers in Fishery Journals

Eschmeyer, P. H. 1990. Usage and style in fishery manuscripts. Pages 1–25 *in* J. Hunter, editor. Writing for fishery journals. American Fisheries Society, Bethesda, Md. 102 pp.

Style Guide for Papers in the Medical Sciences

Schwager, E. 1991. Medical English usage and abusage. The Oryx Press, Phoenix, Ariz. 216 pp.

Style Guides for Nonsexist Usage

International Association of Business Communicators. 1982. Without bias: a guidebook for nondiscriminatory communication. Wiley & Sons, New York, N.Y. 200 pp.

Miller, C., and K. Swift. 1988. The handbook of nonsexist writing. Second edition. Harper & Row, New York, N.Y. 180 pp.

Manuals for English Grammar

Brusaw, C. T., G. J. Alred, and W. E. Oliu. 1993. Handbook of technical writing. Fourth edition. St. Martin's Press, Inc., New York, N.Y. 803 pp.

Hacker, D. 1991. The Bedford handbook for writers. Bedford Books of St. Martin's Press, Boston, Mass. 689 pp.

Sabin, W. A. 1993. The Gregg reference manual. Seventh edition. MacMillan/McGraw-Hill, New York, N.Y. 502 pp.

Warriner, J. E., and F. Griffith. 1977. English grammar and composition. Heritage edition. Complete course. Harcourt Brace Jovanovich, New York, N.Y. 711 pp.

Appendix B. Common faulty usage and other flaws in technical reports. A personal collection by the author.

abbreviations	Abbreviations that are pronounced as abbreviations (e.g., EPA, DNR, DNA) have no articles. If a publisher does not allow such abbreviations at the beginning of a sentence, the terms must be spelled out. In general, abbreviations are for the convenience of the readers rather than the author. Unless necessary, conventional, or convenient for the readers, abbreviations in the text are inappropriate. If used in a table or figure, a legend must be provided.
and/or	*and/or* is a legalism that carries the same meaning as *or*; in most sentences, the meaning of two words joined by *or* includes the meaning of those same two words joined by *and*.
to appear	*To appear* is not synonymous with *to seem*; for example, an actor appears on the stage and seems to have forgotten his lines.
both	When *both* indicates duality, it is needed only for emphasis. It is usually superfluous.
to compare	*Compare to* addresses similarities (e.g., to compare the sound of hooves to thunder); *compare with* is used in the examination of ways in which two things are similar (e.g., to compare the song of *Turdus migratorius* with the song of *Pheucticus ludovicianus*). Neither form must be used in place of *than* (e.g., gold is heavier than silver [not, gold is heavier compared to silver]).
to comprise	The whole comprises the parts, but the parts do not comprise the whole. For example, *The state comprises 51 counties* or *The state consists of 51 counties*. (not: *The state is comprised of . . .*).
diet	*Diet* is not synonymous with *feed*. Whereas diet is food and drink in terms of quality and composition and effects on health or a particular selection of food that is designed or prescribed to improve an individual's physical condition or to prevent or treat a disease, feed is food given to farm animals including fishes in hatcheries.
differ from different from	*Differ* and *different* are followed by the preposition *from*, not by the preposition *than*. For example, the growth rate in Sample A differed from the growth rate in Sample B or the growth rate in Sample A was different from the growth rate in Sample B.
dissimilar to	*Dissimilar* is followed by the preposition *to*, not by the preposition *from*. For example, Surface-feeding ducks are dissimilar to diving ducks in morphological characteristics.
dose, dosage	A *dose* is the quantity that is administered at one time or the totally administered quantity. *Dosage* is the regulation or frequency of doses.
due to	*Due to* requires a linkage verb, which is usually a form of *to be*. For example: The deterioration of the habitat was due to drought. *Due to* cannot be used in place of *because of*. For example: Because of wetland drainage, the population size of frogs in the region declined.

it and there	The use of *it* and *there* with indefinite references is too imprecise for technical and scientific texts (unless, e.g., *it is raining*) and creates laborious reading. For example, the sentence *There was not enough water in the pond* can be recast to *Not enough water was in the pond*. Similarly, *It is difficult to see warblers in leaved trees* can be recast *Warblers are difficult to see in leaved trees*.
respectively	A sentence structure with *respectively* that obliges the reader to match up things that appear earlier in the sentence is impolite and, therefore, inappropriate.
that, which	Some authorities are not opposed to the interchangeable use of *that* and *which*. However, many writers and editors prefer to use *that* to introduce a restrictive clause and *which* to introduce a nonrestrictive clause. For example, *that* in *A sentence that obliges readers to match up things should be recast* restricts the recasting to the sentence that obliges readers to match things. The clause that is introduced by *which* in *A popular book, which is no longer in print, features many examples of faulty sentence structure* is nonrestrictive because *is no longer in print* is not a prerequisite but merely a digression of *features many examples of faulty sentence structure*. Unlike nonrestrictive clauses, restrictive clauses are not set off by commas. However, the distinctions between restrictive and nonrestrictive clauses are not always absolute, irrespective of commas and usage.
using	The replacement of with with *using* is widespread but awkward and sometimes creates ambiguities. For example, *we observed ducks using binoculars* should read *we used binoculars to observe ducks*. *We rinsed samples using distilled water* should read *We rinsed samples with distilled water*. The faulty usage of *with* is addressed in more detail by Eschmeyer (1990).
via	*Via* cannot be used to convey the meaning of *by means of*. *We traveled from Woodbridge to Washington via Springfield* is correct, but *We traveled to Washington via automobile* is incorrect.
with	*With* must not be used to connect unrelated elements. For example, *The samples were rinsed in water with containers first having been sterilized* must be recast, for example, *The samples were rinsed in water from sterilized containers*.
within	*Within* is not synonymous with *in* or *inside*. For example, *the ambulance came within 5 min* or *we stopped within 2 m of the wall*. However, *ducks forage in wetlands*, and *zoo animals are inside enclosures*.

Appendix C. *Checklist for Contributors to the Technical Report Series* of the National Biological Survey. [1]

Submission of the Manuscript

___DOS format—WordPerfect 5.1 preferred, disk of either size or capacity
___Disks are labeled with author name and file names
___Two complete copies of the manuscript are ready to forward
___Manuscript Transmittal Form (3-1904) is completed, current addresses and phone numbers of all authors are included
___Original figures are legible and labeled
___Manuscript is submitted exclusively to series

Preparation of the Manuscript

___Laser-printed on one side of good quality white paper
___Pages are numbered
___All text is double-spaced
___Levels of headings are identified and checked; not more than four levels

Title

___Title is specific and concise (10 or fewer words)
___No scientific names are used in title (unless taxonomic treatise)

Author Affiliation

___First names, initials, and surnames or first initials, second names, and surnames are used
___Professional titles and academic degrees are omitted
___Author name is followed by federal agency
___Name of center or office, street address, state name spelled out, postal code are included
___Current address (if different from where work was done) is given as footnote at bottom of first page

Abstract

___The lesser of <250 words or <3% of length of the article
___Findings are presented, rather than a list of subjects covered
___No references in abstract
___Scientific names are given
___All items in abstract are also covered in text
___Abstract is a single paragraph
___Abbreviations given in Abstract are also used in Abstract

Key Words

___Key words follow abstract
___List is preceded by "**Key words:**"
___5–8 key words or phrases are listed

[1]Unpublished; developed by the Quality Management Council of the Publication Services Branch, Information Transfer Center, Fort Collins, Colo.

Acknowledgments

___Only direct help is acknowledged (omitted typists, illustrators, editors, and referees)
___Only forename initial(s) are used with surname; omitted titles and degrees
___Funding source is acknowledged
___Placed ahead of Cited Literature

Cited Literature

___Only cited works are listed
___Citations follow the *CBE Style Manual*, 3rd edition
___Citations carefully checked for omissions, spelling, and mistakes in dates, pages, and titles
___Page numbers are included when citing entire books
___Used name-and-year system for citations in text
___Used "et al." in text when citation has more than two authors
___No comma between author and year in text citation
___Citations in the same parentheses are separated by ";" and in chronological order
___Sources of personal communication and citation are not listed in Cited Literature<%-8>___<%0>place in parentheses in text
___Articles "in press" are listed in Cited Literature
___Names of publications are spelled out in full

Appendixes

___Used sparingly or not at all (i.e., appendixes are required for logical and orderly presentation of material or material needed by specialists)
___Order is designated by capital letters
___A single appendix is referred to as "Appendix"

Footnotes

___Footnotes are avoided in text where possible
___If footnotes are used, those in text are numbered, those in tables are lettered
___In-text footnotes are separated from text by a short line on page where used
___Footnotes in tables are placed below table
___Sequence of footnotes in tables is from left to right, row by row, top to bottom

Tables

___If using WordPerfect 5.1, use Table—not Column—function to set up tables
___All typing is double spaced, including title and footnotes
___Each table is typed on a separate page and each is cited in order in the text
___Tables numbered sequentially with Arabic numerals (if only one, it is referred to as "Table")
___Headings and notes are self-explanatory
___Tables have similar style
___Box headings are subtended by horizontal rules
___Tables are closed with a foot rule
___Vertical lines are not used in the tables
___Table headings are brief and informative but complete
___Scientific names in title and headings are spelled out
___Column and stub headings are clear
___Footnotes are preceded by lowercase superscript letters
___Field of the table is clear, simple, and organized
___Columns are separated with tabs, not spaces
___Words are aligned on left, numbers are aligned on decimal

___A “0” is used before decimal points not preceded by a number (0.5, not .5)
___Columns with minimal data are deleted
___Absence of material is denoted by a blank space
___All but first word and proper nouns lowercased in headings and text entries

Figures (illustrations)

___Figures appear professional—lettering not typewritten or freehand
___Upper- and lowercase letters are used for labels
___Figures are numbered sequentially (e.g., Fig. 1, Fig. 2) in the text (if only one, it is referred to as “Figure”)
___Line drawings are in ink
___Lettering is similar on all figures
___Halftones are sharp, glossy, unmounted prints
___Photocopies are acceptable for draft; originals must accompany final draft
___Illustrations are 8½ × 11 inches or smaller (color plates require approval; Form DI-550)
___Illustrations—including labeling—are proportioned for reduction to about two-thirds of the original size
___Each figure is on a separate sheet and placed at end of the manuscript
___Ballpoint pen is not used on backs of figures
___Figures are labeled with author name and figure number on the back-top
___Figures are protected by cardboard for mailing
___Each figure has a separate caption, including number and brief description (usually one sentence), has no footnotes, and is fully self-explanatory
___Figure captions are placed at the end of the manuscript
___Suggestions are made for a cover illustration
___Figures prepared in graphics packages are accompanied by a labeled disk and a hard copy

Usage and Style

___The day-month-year style is used for dates
___Range of dates is in full in all titles and captions (1988–1993)
___Dates are abbreviated in text (1988–93), plurals formed by apostrophe and an *s* (1980's)
___Time is reported by 24-h clock—10:15 p.m. is 2215 h (add 1200 to any time past 1 p.m.)
___Standard abbreviations s, min, h are used for short time intervals (no *s* for plurals)
___Longer time units (day, week, month, year) are not abbreviated
___Centuries and decades are spelled out (the twentieth century, the sixties)

Scientific Names

___Scientific names are correct
___First use of scientific name is complete and indicated for italics
___Subsequent uses follow the latest *Guide for Contributors to the Technical Report Series*
___Common names of organisms (except proper names) are in lower case

Numbers

___A numeral is used to precede any unit of measure, except when beginning a sentence
___Numerals are used to express date, time, page number, percentage, decimal quantity, or numerical designation; numerals are used in arithmetic and statistical expressions and for numbers that are grouped for comparison
___Numbers one through nine are spelled out, numerals are used for larger numbers; ordinal numbers are treated the same as cardinal numbers
___Numbers in a series are all numerals
___Numbers at the beginning of a sentence are spelled out; numerals are used for the rest of the sentence if in series or fits the described rules

Abbreviations

___Avoided in title
___Placed in parentheses after first mention of spelled-out expression (no periods or spaces<%-4>___<%0>NATO)
___Defined both in abstract (if used) and in text
___Used "e.g." and "i.e." only in parentheses in tables, figure captions, and text and followed with a comma
___Standard units of measure are abbreviated after a numeral (10 mm)
___Spelled out day, week, month, and year after a numeral
___Spelled out state in author address
___Names of states are abbreviated in footnotes and citations (e.g., Colo., not CO)
___"U.S." abbreviated only as an adjective; spelled out as a noun

Italics

___Used for second-order heads and scientific names and shown by underlining
___Used for single letters that denote mathematical constants, variables, unknown quantities in the text, and in equations
___Not used for "in vivo," "et al.," "i.e.," "cf.," "vs.," or other Latin terms or abbreviations

Units of Measure

___Used metric units throughout
___Abbreviated standard units of measure when with a numeral; spelled out units of measure if no quantity is given
___Used a "/" for ratios with numbers (10 deer/ha); used "per" for ratios without numbers (deer per hectare)
___Plurals not used when abbreviated (do not add *s*)
___Retained only the final unit of measure in a series (from 10 to 15°C)
___Used Celsius and not Fahrenheit scale

Signs and Symbols

___Left equal spaces before and after mathematical operating terms (+, –, ×, /, =) in an equation
___Used "°" with a numeral (10°C)
___Used the "%" with a numeral (12%)
___Used the prescribed statistical symbols and abbreviations from page 7 of the *Guide for Contributors to the Technical Report Series*

U.S. Department of the Interior
National Biological Survey

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering the sound use of our lands and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsiblity for American Indian reservation communities and for people who live in island territories under U.S. administration.